US009194847B2

(12) **United States Patent**
Burnett et al.

(10) **Patent No.: US 9,194,847 B2**
(45) **Date of Patent: Nov. 24, 2015**

(54) **SAMPLE TRAY WITH MAGNETICALLY CLOSING DRAWER**

(75) Inventors: **Joshua A. Burnett**, Taunton, MA (US); **James E. Usowicz**, Webster, MA (US); **Daniel J. Gagne**, Smithfield, RI (US); **Keith McGrath**, Milford, MA (US); **Edwin Denecke**, North Attleboro, MA (US)

(73) Assignee: **Waters Technologies Corporation**, Milford, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 548 days.

(21) Appl. No.: **13/519,785**

(22) PCT Filed: **Jan. 11, 2011**

(86) PCT No.: **PCT/US2011/020749**

§ 371 (c)(1),
(2), (4) Date: **Aug. 22, 2012**

(87) PCT Pub. No.: **WO2011/085342**

PCT Pub. Date: **Jul. 14, 2011**

(65) **Prior Publication Data**

US 2014/0079606 A1 Mar. 20, 2014

Related U.S. Application Data

(60) Provisional application No. 61/293,845, filed on Jan. 11, 2010.

(51) **Int. Cl.**
B01L 99/00 (2010.01)
G01N 30/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G01N 30/24*** (2013.01); ***G01N 30/16*** (2013.01); *G01N 30/20* (2013.01); *G01N 2035/00287* (2013.01); *G01N 2035/00346* (2013.01); *G01N 2035/0498* (2013.01)

(58) **Field of Classification Search**
CPC B01L 2300/04; B01L 99/00; A47B 81/00; G01N 30/02
USPC 73/61.52–61.59; 422/70, 560–562, 565; 206/557–561; 312/333
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,027,934 A 6/1977 Wiser
4,678,081 A 7/1987 Richter
(Continued)

FOREIGN PATENT DOCUMENTS

EP 0902271 A2 3/1999
FR 2788042 A1 7/2000
(Continued)

OTHER PUBLICATIONS

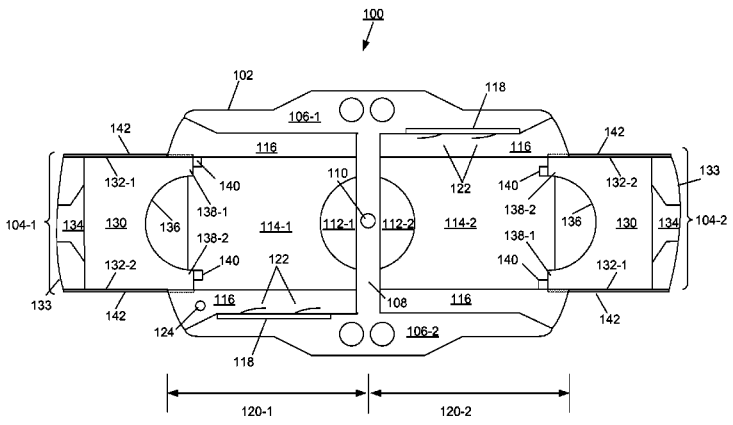
Machine translation KR20-0442123, downloaded Apr. 5, 2015.*
(Continued)

Primary Examiner — Jan Ludlow
(74) *Attorney, Agent, or Firm* — Schmeiser, Olsen & Watts LLP

(57) **ABSTRACT**

A sample manager of a liquid chromatography system uses a sample tray having a base with side walls separated by a cross wall that divides the base into two compartments. The side walls and cross wall bound each compartment on three sides. A fourth side of each compartment is open. Each compartment is sized to closely receive a sample-vial carrier. Each compartment has a magnet affixed to a bottom surface at an edge of the open fourth side. Each of two drawers slides into the open fourth side of one compartment. Each drawer has a support surface with a magnet affixed at an edge of its bottom side, which aligns with the magnet affixed to the bottom surface of the compartment. The magnet of the drawer and the magnet of the compartment bias the drawer into its compartment when the magnets are brought into proximity of each other.

12 Claims, 12 Drawing Sheets



(51) **Int. Cl.**

G01N 30/16	(2006.01)
G01N 35/00	(2006.01)
G01N 30/20	(2006.01)
G01N 35/04	(2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,483,843	A	1/1996	Miller et al.	
5,900,557	A	5/1999	Tanihata et al.	
7,329,393	B2	2/2008	Backes et al.	
7,390,390	B2	6/2008	Yamamoto et al.	
2008/0172023	A1	7/2008	Thompson et al.	
2014/0286124	A1*	9/2014	Donohue et al.	366/342

FOREIGN PATENT DOCUMENTS

KR	20-0442123	*	10/2008
KR	20-0442123	Y1	10/2008

OTHER PUBLICATIONS

Extended European Search Report in related European Patent Application No. 11732295.8, mailed on May 28, 2014; 7 pages.

International Search Report and Written Opinion in counterpart international application No. PCT/US2011/02749 dated Mar. 7, 2011; 8 pages.

* cited by examiner

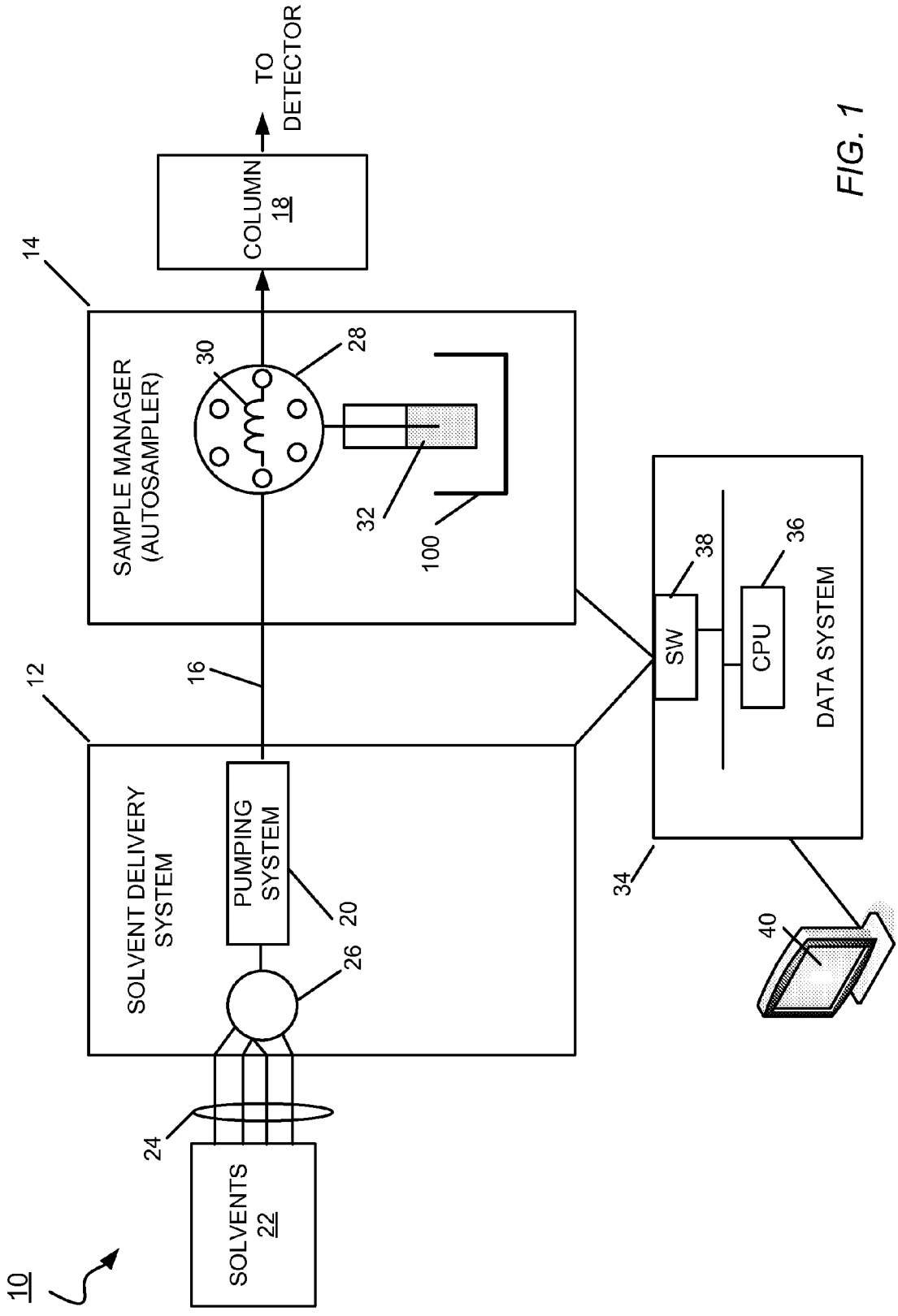

10
SOLVENTS
22
24
SOLVENT DELIVERY SYSTEM
12
PUMPING SYSTEM
20
26
16
SAMPLE MANAGER (AUTOSAMPLER)
14
30
28
32
100
COLUMN
18
TO DETECTOR
DATA SYSTEM
34
SW
38
CPU
36
40

FIG. 1

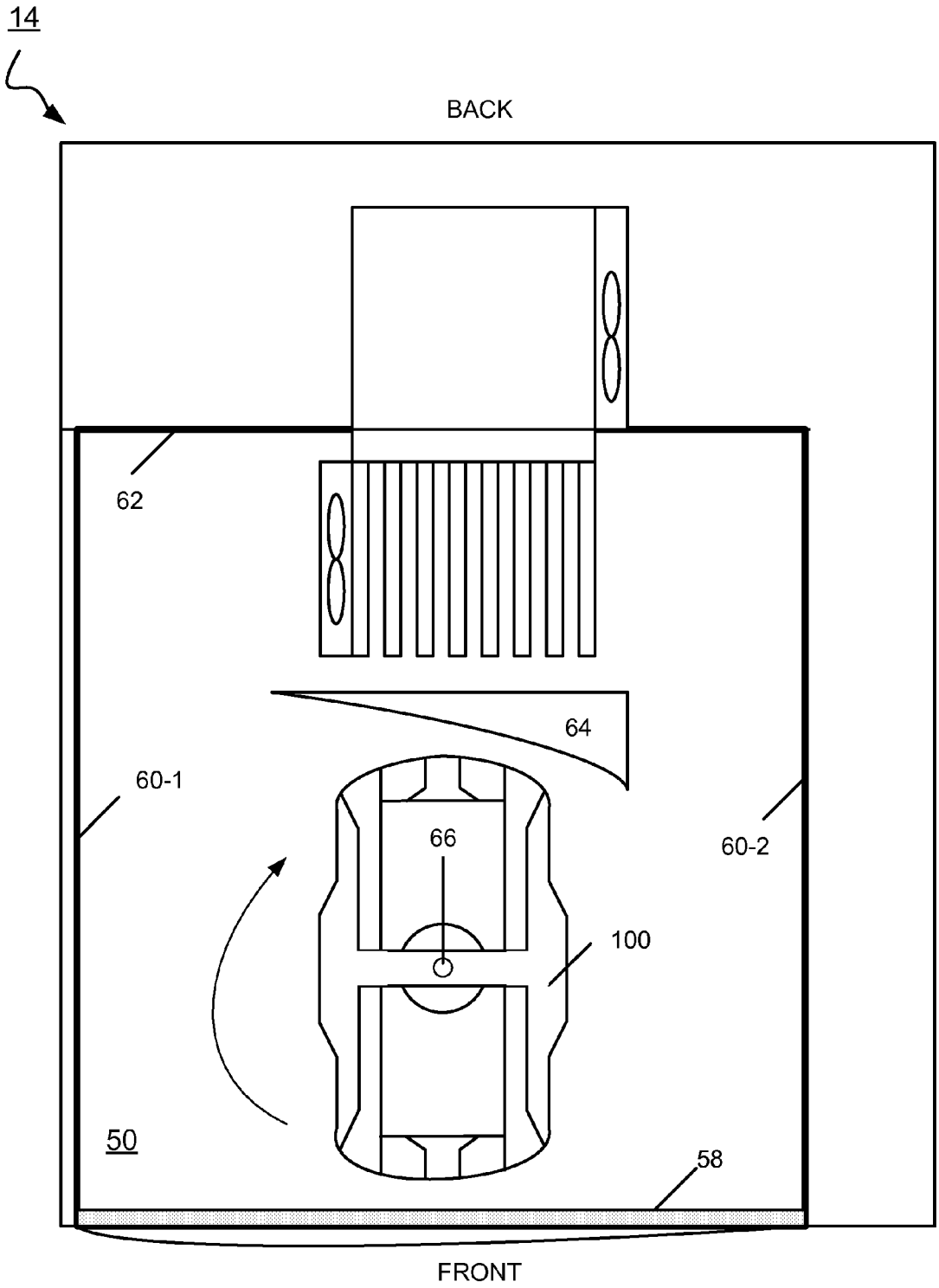


FIG. 2

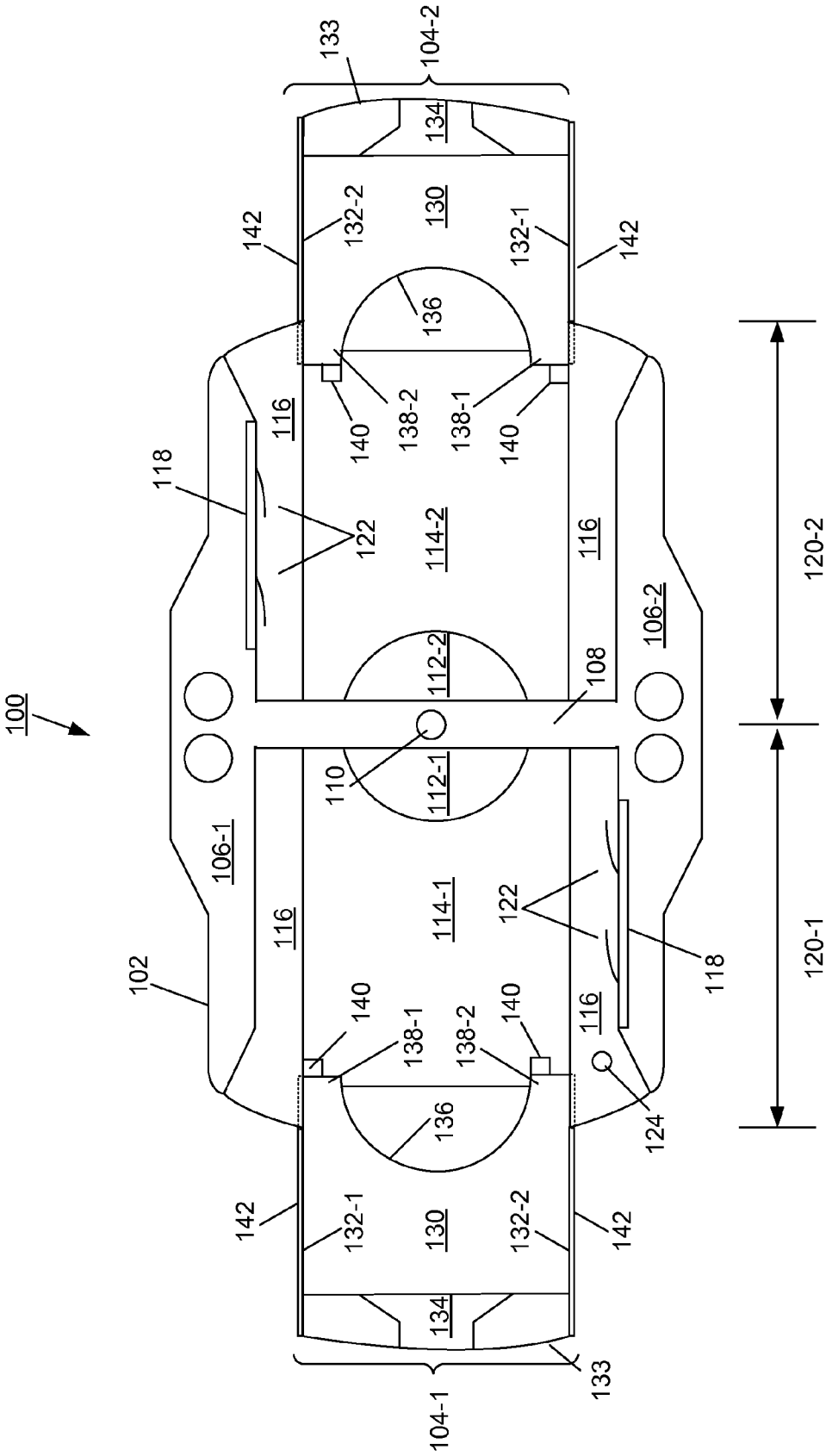

100
102
104-1
104-2
106-1
106-2
108
110
112-1
112-2
114-1
114-2
116
118
120-1
120-2
122
124
130
132-1
132-2
133
134
136
138-1
138-2
140
142

FIG. 3

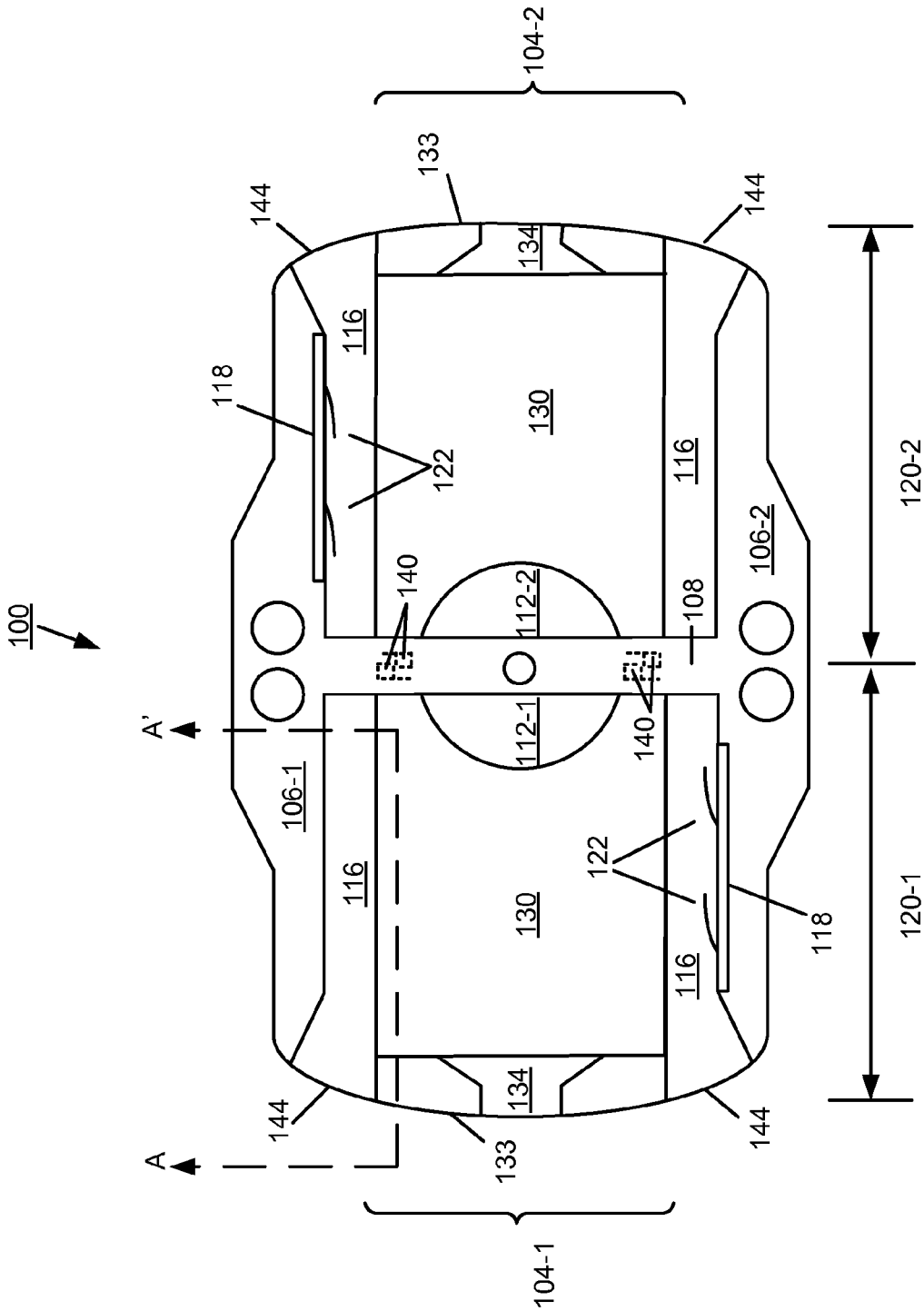

100
104-2
133
144
134
116
118
122
130
140
112-2
108
106-2
120-2
A'
112-1
106-1
120-1
A
104-1

FIG. 4

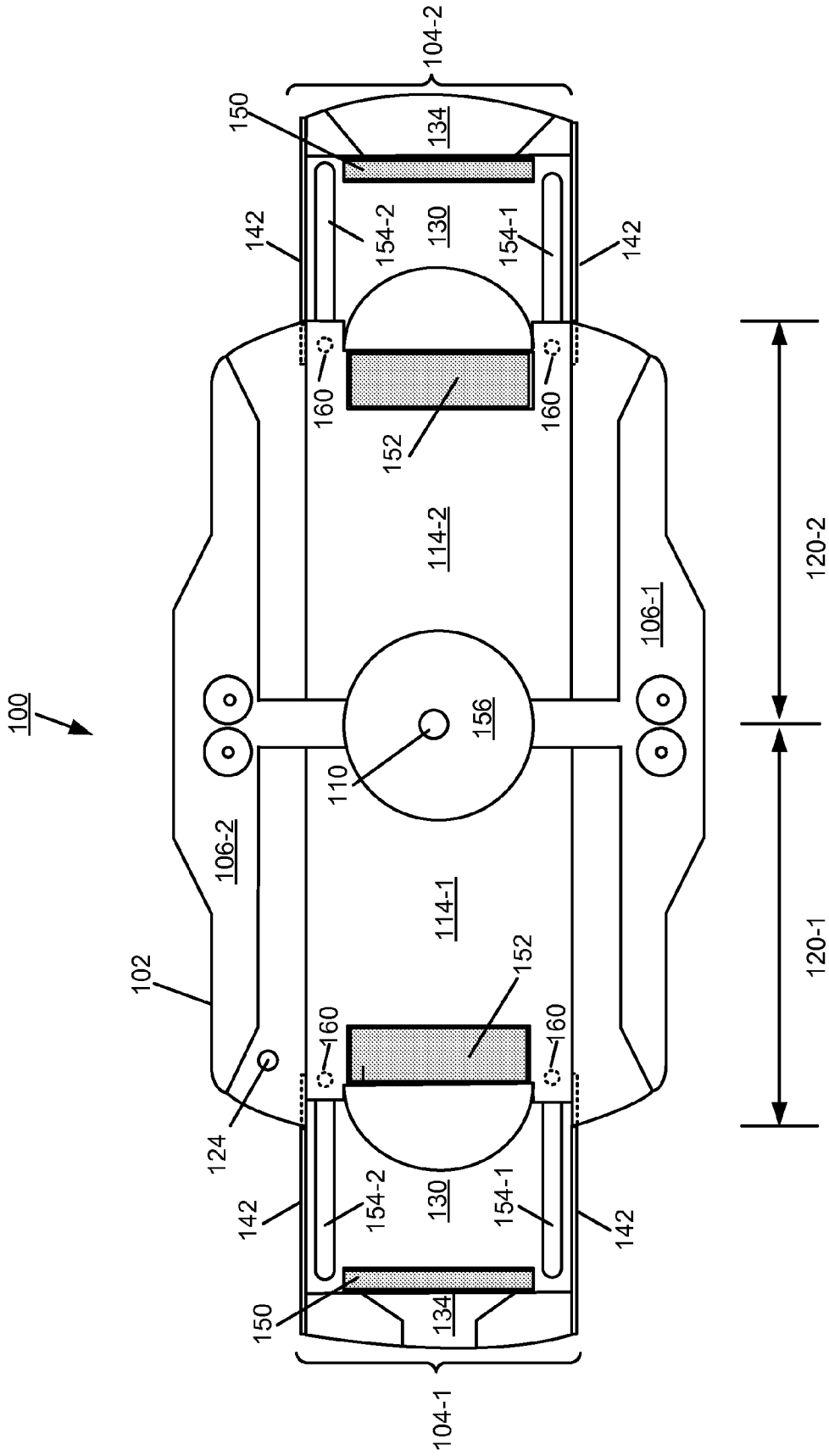

100
102
104-1
104-2
106-1
106-2
110
114-1
114-2
120-1
120-2
124
130
134
142
150
152
154-1
154-2
156
160

FIG. 5

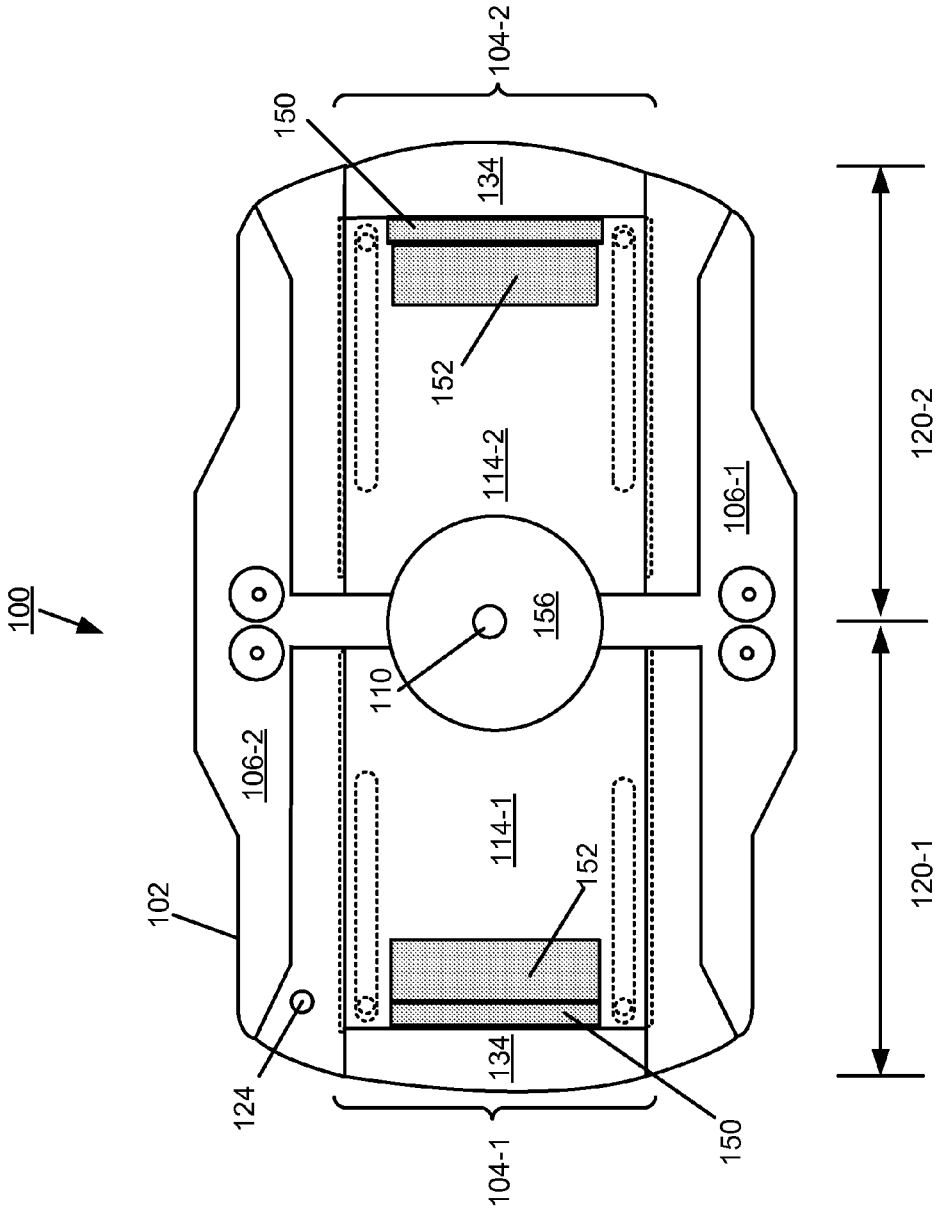

100
102
104-1
104-2
106-1
106-2
110
114-1
114-2
120-1
120-2
124
134
150
152
156

FIG. 6

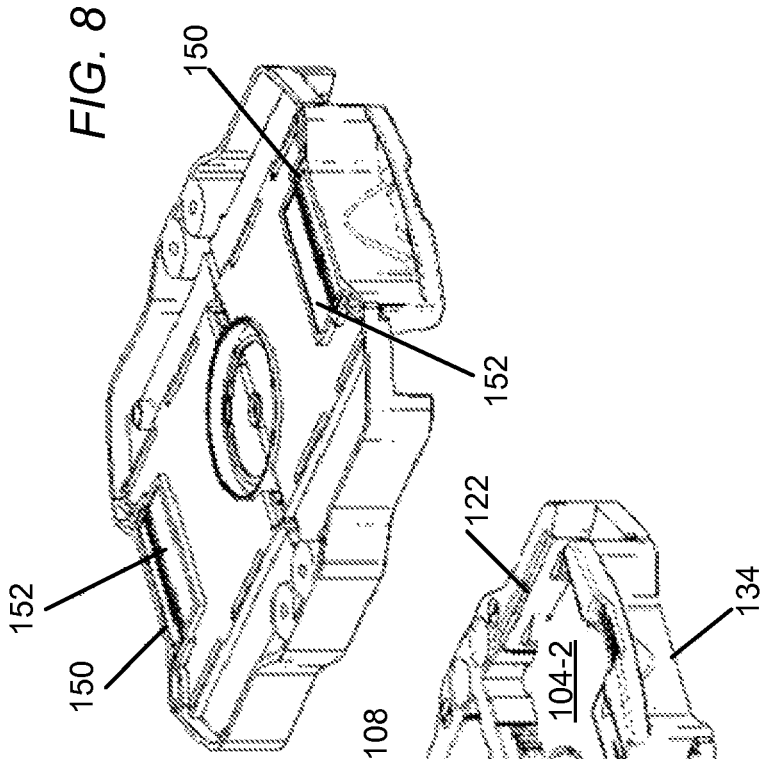


FIG. 8

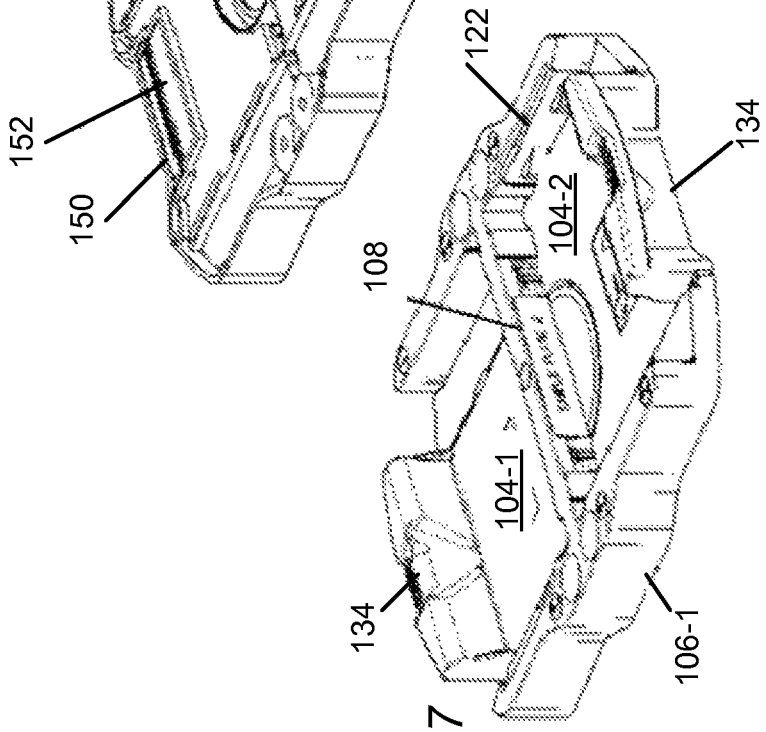


FIG. 7

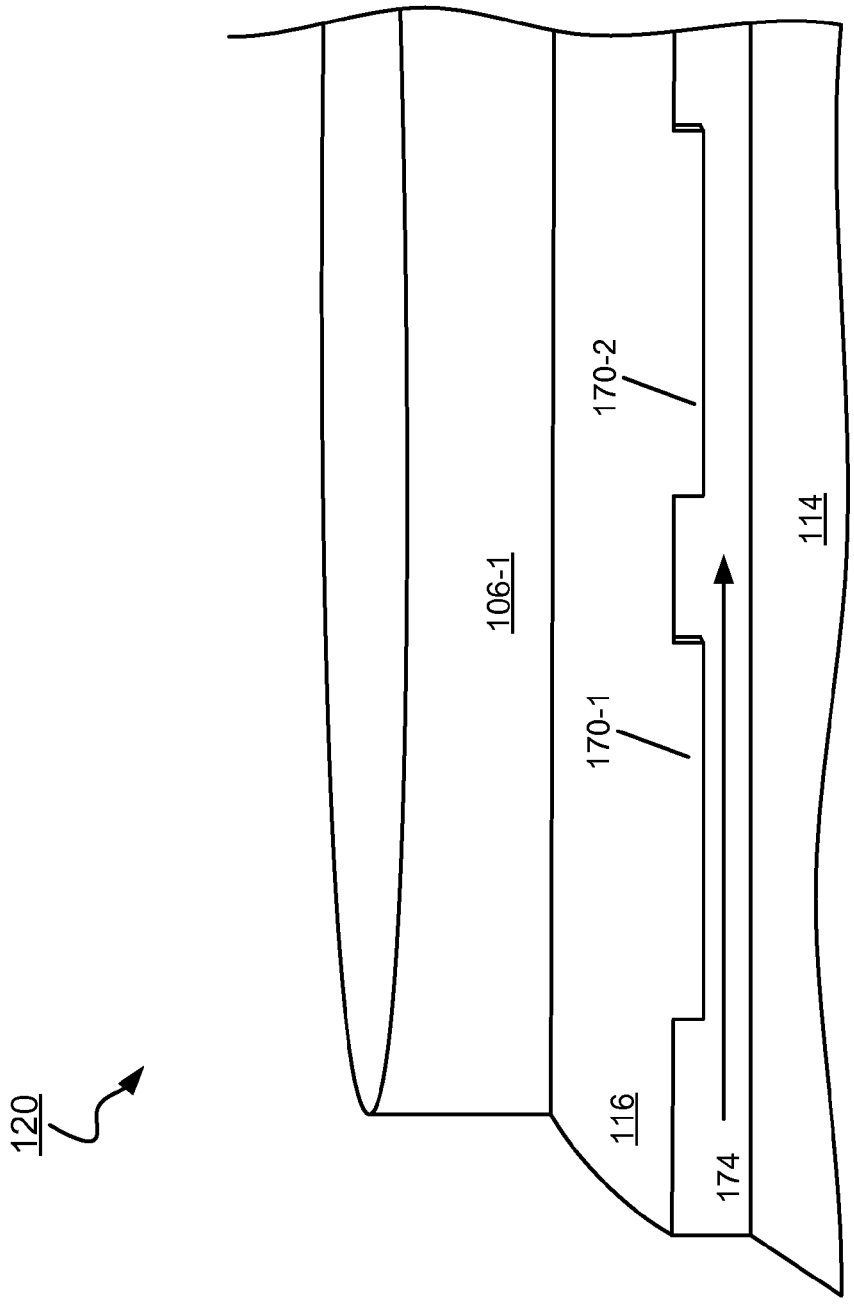


FIG.9

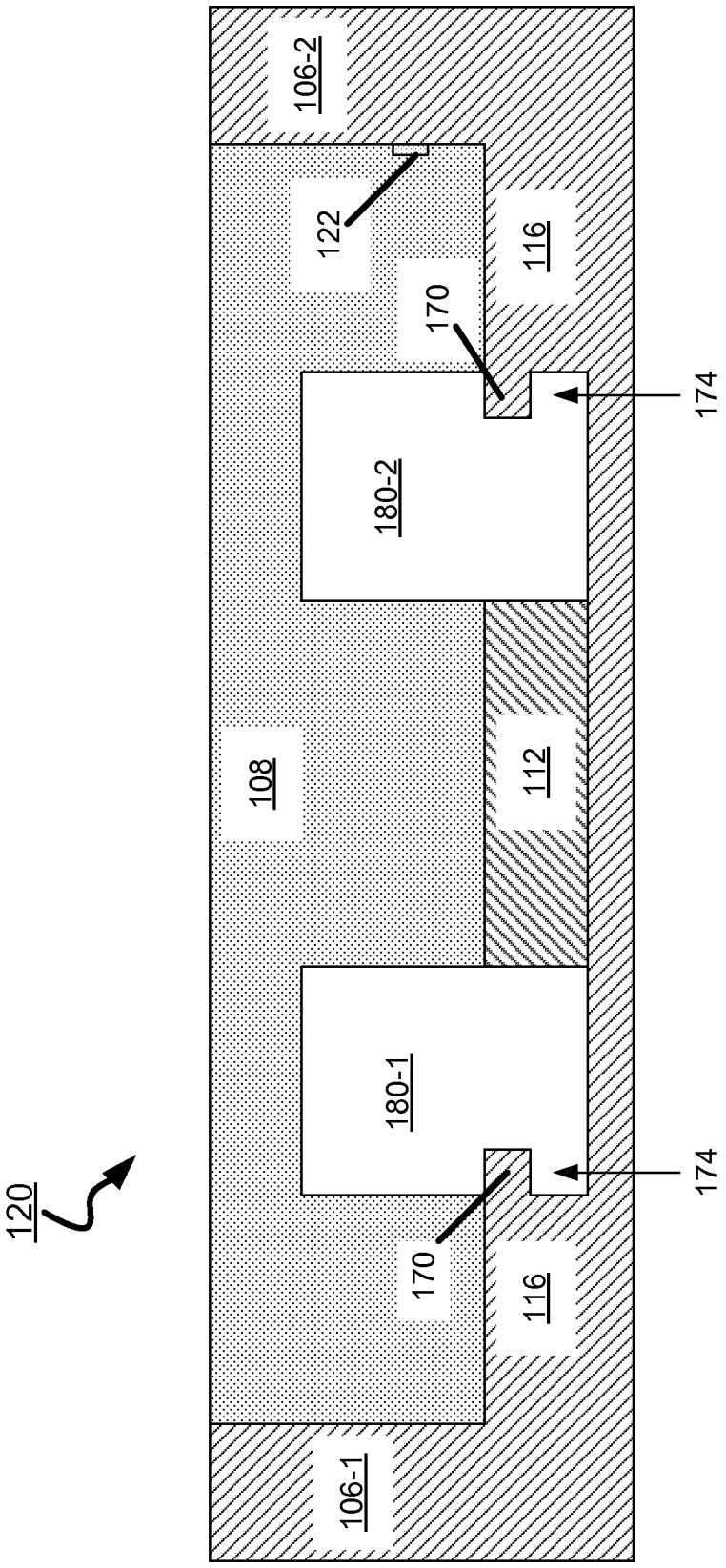


FIG. 10

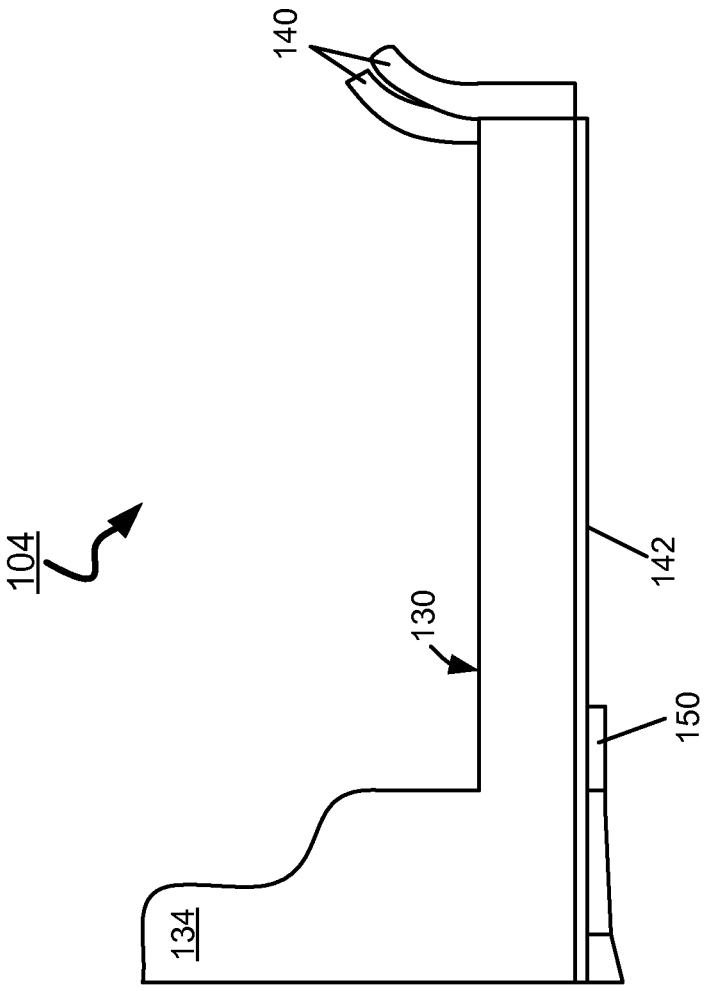


FIG. 11

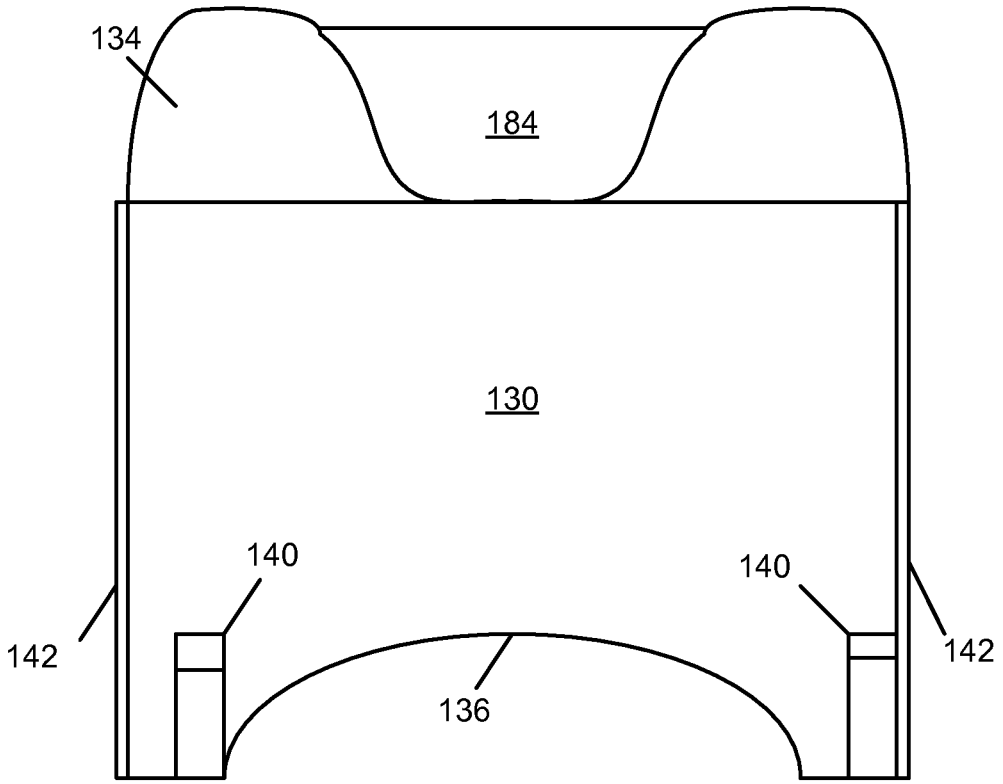


FIG. 12

FIG. 13

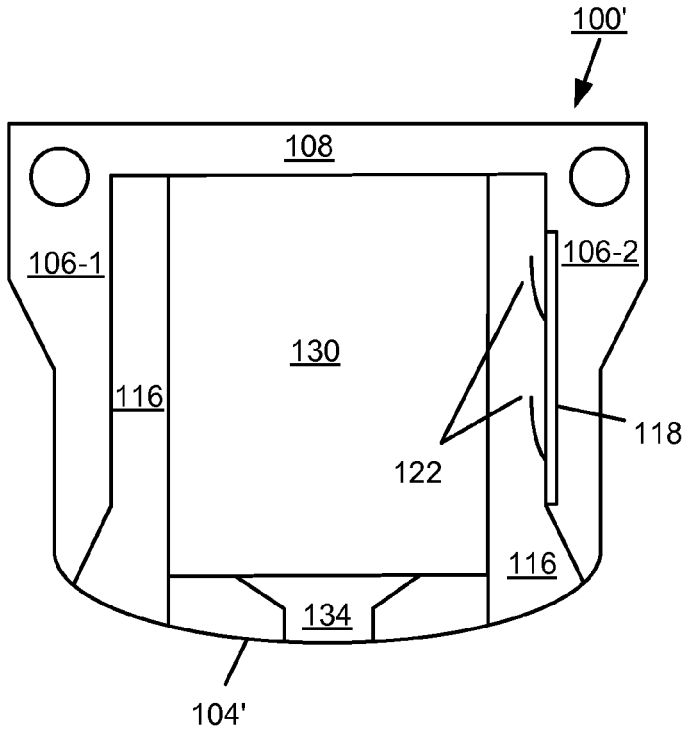
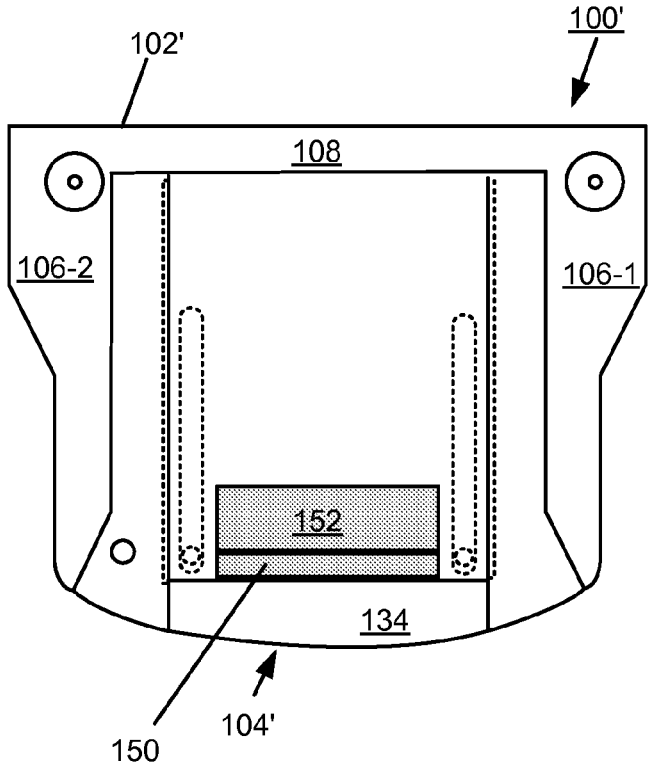

100'
108
106-1
106-2
130
116
118
122
116
134
104'

FIG. 14


102'
100'
108
106-2
106-1
152
134
150
104'

SAMPLE TRAY WITH MAGNETICALLY CLOSING DRAWER

RELATED APPLICATION

This application claims priority to and the benefit of U.S. provisional application Ser. No. 61/293,845, filed on Jan. 11, 2010, the entirety of which application is incorporated by reference herein.

FIELD OF THE INVENTION

The invention relates generally to liquid chromatography systems. More specifically, the invention relates to sample trays used in a sample manager of a liquid chromatography system.

BACKGROUND

Chromatography is a set of techniques for separating a mixture into its constituents. For instance, in a liquid chromatography application, a pump takes in and delivers a mixture of liquid solvents to a sample manager, where an injected sample awaits its arrival. In an isocratic chromatography application, the composition of the liquid solvents remains unchanged, whereas in a gradient chromatography application, the solvent composition varies over time. The mobile phase, comprised of a sample dissolved in a mixture of solvents, passes to a column, referred to as the stationary phase. By passing the mixture through the column, the various components in the sample separate from each other at different rates and thus elute from the column at different times. A detector receives the elution from the column and produces an output from which the identity and quantity of the analytes may be determined.

SUMMARY

In one aspect, the invention features a sample tray for use in a sample manager of a liquid chromatography system. The sample tray comprises a base with opposing spaced-apart side walls separated by a cross wall that divides the base into two compartments, with one compartment on each side of the cross wall. The side walls and cross wall bound each of the two compartments on three sides, with a fourth side of each compartment being open. Each compartment is sized to closely receive a sample-vial carrier. Each compartment has a surface with a magnet affixed to an underside of the surface at an edge of the open fourth side of that compartment.

A pair of drawers is slidably coupled to the base. Each drawer slides into the open fourth side of one of the two compartments over the surface of that compartment. Each drawer has a support surface for supporting a sample-vial carrier. The support surface has a top side and a bottom side. The support surface of each drawer has a magnet affixed on the bottom side. The magnet on the bottom side of the support surface of each drawer is in alignment with the magnet affixed to the bottom surface of the compartment into which that drawer slides. The magnet of each drawer and the magnet of the compartment into which that drawer slides bias that drawer into its compartment when the magnets are brought into proximity of each other.

In another aspect, the invention features a sample tray for use in a sample manager of a liquid chromatography system. The sample tray includes a with opposing spaced-apart side walls separated by a back wall. The side walls and back wall bound a compartment on three sides, with a fourth side of the compartment being open. The compartment is sized to closely receive a sample-vial carrier. The compartment has a top surface and a bottom surface with a magnet affixed to the bottom surface at an edge of the open fourth side of that compartment.

A drawer is slidably coupled to the base for sliding into the compartment through the open fourth side. The drawer has a support surface for closely receiving a sample-vial carrier. The support surface has a top side and a bottom side. The support surface of the drawer has a magnet affixed on the bottom side. The magnet on the bottom side of the support surface is in alignment with the magnet affixed to the bottom surface of the compartment along a path taken by the drawer when sliding into the compartment. The magnets bias the drawer into compartment when brought into proximity of each other.

In still other aspects, the invention features a liquid chromatography system and a sample manager comprising a thermal chamber and a sample tray mounted within the thermal chamber. The sample tray comprises a base having opposing spaced-apart side walls separated by a cross wall that divides the base into two compartments, with one compartment on each side of the cross wall. The side walls and cross wall bound each of the two compartments on three sides, with a fourth side of each compartment being open. Each compartment is sized to closely receive a sample-vial carrier. Each compartment has a top surface and a bottom surface with a magnet affixed to the bottom surface at an edge of the open fourth side of that compartment.

A pair of drawers is slidably coupled to the base. Each drawer sliding into the open fourth side of one of the two compartments. Each drawer has a support surface for supporting a sample-vial carrier. The support surface has a top side and a bottom side. The support surface of each drawer has a magnet affixed at an edge of the bottom side. The magnet at the edge of the bottom side of the support surface of each drawer is in alignment with the magnet affixed to the bottom surface of the compartment into which that drawer slides. The magnet of each drawer and the magnet of the compartment into which that drawer slides biasing that drawer into its compartment when the magnets are brought into proximity of each other.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and further advantages of this invention may be better understood by referring to the following description in conjunction with the accompanying drawings, in which like numerals indicate like structural elements and features in various figures. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

FIG. **1** is a functional block diagram of an embodiment of a liquid chromatography system.

FIG. **2** is a top view of an embodiment of a sample manager.

FIG. **3** is a top view of an embodiment of a sample tray having a pair of magnetically closing drawers.

FIG. **4** is a top view of an embodiment of the sample tray having a pair of magnetically closing drawers in the closed position.

FIG. **5** is a bottom view of the sample tray with the drawers in the open position.

FIG. **6** is a bottom view of the sample tray with the drawers in the closed position.

FIG. **7** is an isometric view of the sample tray with the drawers in the open position.

FIG. **8** is an isometric view of the sample tray with the drawers in the closed position.

FIG. **9** is a side view of a compartment of the sample tray.

FIG. **10** is a front view of a compartment of the sample tray.

FIG. **11** is a side view of a drawer.

FIG. **12** is an elevated rear view of the drawer.

FIG. **13** is a top view of an embodiment of the sample tray having a single magnetically closing drawer.

FIG. **14** is a bottom view of an embodiment of the sample tray having a single magnetically closing drawer.

DETAILED DESCRIPTION

When performing a liquid chromatographic run, a technician loads an array of vials containing samples onto a carrier, places the sample-vial carrier onto a drawer of a sample tray, and slides the drawer into its compartment. As described herein, the sample tray employs magnets to lock the drawer into its compartment; the drawer and the compartment both have a magnet. As the drawer slides into its compartment, the magnets approach each other, and the strength of their magnetic attraction increases. When they are close proximity to each other, the magnets pull the drawer against the compartment with a tactile snapping sensation, thereby providing a positive confirmation to the technician that the drawer has fully closed. One embodiment of a sample tray has two compartments separated by a center wall. The center of the sample tray is coupled to a rotary drive mechanism for rotational movement within the sample chamber of the sample manager.

FIG. **1** shows an embodiment of a liquid chromatography system **10** for separating a mixture into its constituents. The liquid chromatography system **10** includes a solvent delivery system **12** in fluidic communication with a sample manager **14** (also called an injector or an autos ampler) through tubing **16**. The sample manager **14** is in fluidic communication with a chromatographic column **18**. A detector (not shown), for example, a mass spectrometer, is in fluidic communication with the column **18** to receive the elution.

The solvent delivery system **12** includes a pumping system **20** in fluidic communication with solvent reservoirs **22** from which the pumping system **20** draws solvents (liquid) through tubing **24**. In one embodiment, the pumping system **20** is embodied by a low-pressure mixing gradient pumping system having two pumps fluidically connected in series. In the low-pressure gradient pumping system, the mixing of solvents occurs before the pump, and the solvent delivery system **12** has a mixer **26** in fluidic communication with the solvent reservoirs **22** to receive various solvents in metered proportions. This mixing of solvents occurs in accordance with an intake profile, and produces a solvent (mobile phase) composition that varies over time (i.e., the gradient).

The pumping system **20** is in fluidic communication with the mixer **26** to draw a continuous flow of gradient therefrom for delivery to the sample manager **14**. Examples of pumping systems that can be used to implement the pumping system **20** include, but are not limited to, the 2545 Quaternary Gradient Module and the 2555 Quaternary Gradient Module, manufactured by Waters Corp. of Milford, Mass.

The sample manager **14** includes an injector valve **28** having a sample loop **30**. The sample manager **14** operates in one of two states: a load state and an injection state. In the load state, the position of the injector valve **28** is such that the sample manager **14** loads the sample **32** into the sample loop **30**. The sample **32** is drawn from a vial contained by a sample-vial carrier. The sample-vial carrier sits on a sample tray **100** within a thermal chamber of the sample manager **14**. In the injection state, the position of the injector valve **28** changes so that sample manager **14** introduces the sample in the sample loop **30** into the continuously flowing mobile phase from the solvent delivery system. The mobile phase thus carries the sample into the column **18**.

The liquid chromatography system **10** further includes a data system **34** that is in signal communication with the solvent delivery system **12** and the sample manager **14**. The data system **34** has a processor **36** and a switch **38** (e.g., an Ethernet switch) for handling signal communication between the solvent delivery system **12** and sample manager **14**, as described herein. Signal communication among the various systems and instruments can be electrical or optical, using wireless or wired transmission. A host computing system **40** is in communication with the data system **34** by which a technician can download various parameters and profiles (e.g., an intake velocity profile) to the data system **34**.

FIG. **2** shows top view of an embodiment of the sample manager **14** including a sample chamber **50** having a front wall **56** with a door **58**, side walls **60-1**, **60-2**, and a back wall **62**. Within the sample chamber **50** is an interior wall **64** used to form an air duct along the back wall **62** and a two-compartment sample tray **100** coupled to a rotary drive mechanism (not shown, being beneath the sample tray and a datum plate) for rotational movement about a pivot point **66**. In general, a technician inserts or removes a sample-vial carrier from the compartment that is the closer of the two to the door **58**.

FIG. **3** shows a top view of an embodiment of the sample tray **100** having a base **102** and a pair of magnetically closing drawers **104-1**, **104-2** (generally, **104**). As shown, the drawers **104** are fully open, which is their preferred orientation for placing a sample vial carrier onto a drawer. The base **102** has opposing side walls **106-1**, **106-2** (generally, **106**) and a cross wall **108** bisecting each side wall **106**. The side walls **106** and cross wall **108** are of uniform height and, when viewed from above, together form the capital letter H, with the cross-wall **108** dividing the sample tray **100** into two compartments **120-1**, **120-2** (generally, **120**). The two compartments **120** are symmetrically inverted, like the two halves of a playing card. Each compartment can hold a rectangular 3.5"×5" sample-vial carrier. In one embodiment, the compartments are approximately 5" wide by 3.5" deep. Alternatively, the compartments can be 3.5" wide by 5" deep (provided the sample chamber is large enough for this length of sample tray). Compartments can also be designed to support sample-vial carriers of different dimensions without departing from the principles of the invention.

Midway in the cross wall **108** is a circular opening **110** for receiving a bolt or a post by which to secure the sample tray **100** to a rotary drive mechanism disposed below the sample chamber. On each of the opposite sides of the cross wall **108** is a semicircular platform **112-1**, **112-2** (generally, **112**). The semicircular platforms **112** rise above sunken surfaces **114-1**, **114-2** (generally, **114**) of the base **102**. The two semicircular platforms **112** are opposite halves of a circular platform bisected by the cross wall. This circular platform and the circular opening **110** in the cross wall are concentric.

Along each side wall **106**, on both sides of the cross wall **108**, is a platform **116** raised above the plane of the depressed surfaces **114**. Each side wall **106-1**, **106-2** has an indent **118** and, within that indent, a pair of metallic leaf springs **122** extending laterally from the side wall. The leaf springs **122** are catty-cornered across the sample tray.

The sample tray has one calibration hole **124**, which is located in one of the side platforms **116**. The calibration hole **124** is an exception to the inverted symmetry between the tray compartments **120**, there being only one such hole for the

sample tray. In this embodiment, the calibration hole **124** is in the compartment **120-1** of the sample tray and penetrates entirely through the side platform **116** along side wall **106-2**. With the sample tray mounted within the sample chamber, a technician aligns the calibration hole **124** with a hole in the datum plate. A metallic pin is inserted through the calibration hole and datum plate hole. During calibration, an encoder detects this pin and uses it to establish a home (i.e. reference) position from which all other tray positions are known. The pin is removed after calibration.

Each drawer **104** has a planar surface **130** with opposing side edges **132-1**, **132-2** (generally **132**), a handle **134** at a front edge **133**, and an arcuate rear edge **136** that form prongs **138-1**, **138-2** (generally, **138**). Rising at the end of each prong **138** is an arching post **140**. The posts **140** serve as positional guides or locators for directing a sample-vial carrier onto the planar surface **130**. Each side edge **132** has a tongue **142** extending along a length of that edge. The tongues **142** closely enter grooves (FIG. **9**) in the sides of opposite side platforms **116**. As a drawer slides into its compartment, the tongues **142** of the drawer slide through the grooves in the side platforms **116**.

FIG. **4** shows a top view of the sample tray **100** with the drawers **104-1**, **104-2** fully inserted into their respective compartment **120-1**, **120-2**. With the drawer in its compartment, the planar surface **130** of each drawer fits closely between a pair of opposing side platforms **116**. The rear arcuate edge **136** of the drawer closely abuts the semicircular platform **112**, like matching pieces of a puzzle. The arching posts **140** and tips of the prongs **138** pass through openings (FIG. **10**) in the side of the cross wall **108** and stop within close proximity of their counterpart arching posts **140** of the other drawer. The front edge **133** of the drawer forms a smooth, continuous curve with the front edges **144** of the side platforms **116**. The planar surface **130** of the drawer, the semicircular platform **112**, and side platforms **116** are approximately of uniform height to provide a planar surface upon which to hold level a sample-vial carrier. The pair of leaf springs **122** extending from one side wall **106** operates to bias such a sample-vial carrier sitting within the drawer towards the side wall **106** on the opposite side.

FIG. **5** shows a bottom view of the sample tray **100** with its drawers **104-1**, **104-2** fully extended. Affixed to the underside of each drawer **104**, near the handle **134**, is a permanent bar magnet **150**. Another permanent bar magnet **152** is affixed on the underside of the sunken surface **114** of each compartment **120**. The magnets **150**, **152** are oriented to attract each other as the drawer slides into its compartment **120**. When the magnets **150**, **152** come into range of their magnetic pull, the attractive magnetic force snaps the drawer within and against its compartment **120**, giving the technician a tactile sensation that the drawer is fully closed. When the drawer is fully within its compartment, the edges of the magnets **150**, **152** abut each other. In one embodiment, the length, thickness, and width of the bar magnet **150** affixed to the drawer are 2"×0.125"×0.2", respectively, and those of the bar magnet **152** affixed to the sunken surface **114** are 2"×0.125"×0.5", respectively.

The underside of each drawer **104** has a pair of tracks **154-1**, **154-2** (generally, **154**). Each track **154** receives a raised circular nub **160** that projects slightly from the topside of the surface **114**. The nubs **160** slide within the tracks as the drawer slides in and out over the sunken surface **114** of the base **102**. In addition, the raised nubs **160** keep the drawers **104** from detaching from the base.

Directly beneath the semicircular platforms **112** on the top side of the sample tray is a corresponding circular region **156**. The circumference of the circular region **156** rises above the plane of the surrounding surfaces **114-1**, **114-2**; the interior of the circular region **156** lies below the plane. This raised circumference and depressed interior serve to position the sample tray upon a circular dais within the base of the sample chamber **50**. The sample tray is coupled to this circular dais (via the hole **110**).

FIG. **6** shows a bottom view of the sample tray with the drawers **104** fully closed. In the closed position, an edge of the bar magnet **150** on the underside of the drawer abuts an edge of the bar magnet **152** on the underside of the base surface **114**. The attraction between the magnets **150**, **152** is strong enough to keep the drawer secured in the closed position during rotation of the tray, yet sufficiently weak to permit a technician to pull the drawer out of its compartment. Because of permissible tolerances, some sample-vial carriers may have a depth that is slightly larger than the depth of the drawer, thus preventing the drawer from fully closing, that is, the magnets **150**, **152** are unable to abut. Notwithstanding, the attractive force of the magnets is still sufficient to hold the drawer firmly in its compartment **120**.

The combined biasing of the leaf springs **122** and the magnets **150**, **152** operates to urge the A-**1** position of the sample vial carrier within the drawer towards the left-side interior corner of the compartment **120**.

FIG. **7** shows an isometric top view of the sample tray **100**, showing the drawers **104**, including their handles **134** and leaf springs **122**, in detail. FIG. **8** shows an isometric bottom view of the sample tray **100** with the magnets **150**, **152** securing the drawers **104** in their closed positions.

FIG. **9** shows a cross section of one side of a compartment **120** taken along line A-A' in FIG. **4** (with the drawer **104-1** removed). The view shows the side wall **106-1**, the side platform **116** along the bottom of the side wall **106-1**, and a pair of overhanging lips **170-1**, **170-2** (generally, **170**). The lips **170** overhang the sunken surface **114**; together, the lips **170** and surface **114** form a side groove **174** through which the tongue **142** (FIG. **5**) slides as the drawer is moved in and out.

FIG. **10** shows a front view of one compartment **120** of the sample tray, showing the side walls **106-1**, **106-2** separated by the cross-wall **108**. The cross wall has a pair of openings **180-1**, **180-2** (generally, **180**) into which the arching posts **140** and tips of the prongs **138** of a drawer enter when a drawer is fully closed. Extending from each side wall **106** is a side platform **116**, and extending from each side platform **116** are the overhanging lips **170**. The open ends of the side grooves **174** are below the overhanging lips **170**. At the bottom of the cross wall **108**, between the openings **180**, is the semicircular platform **112**. Projecting from a surface of the side wall **106-2** is a leaf spring **122** (end view).

FIG. **11** shows a side view of a drawer **104**. At a front end of the drawer is the handle **134**. The center of the handle is ergonomically shaped to be grasped comfortably between the distal phalange of a person's forefinger and the person's thumb (for pushing and pulling the drawer in and out from the compartment). Affixed to the underside of the drawer, below the handle **134**, is the bar magnet **150**. At the opposite end of the support surface **130** are the arching posts **140**, which bend at their tips away from the drawer. Along a lower edge of the drawer is a tongue **142**.

FIG. **12** is an elevated view of the drawer from the rear end of the drawer. The handle **134** has an indent **184** shaped to receive the person's forefinger. The tongues **142** are on opposite sides of the support surface **130**. The posts **140** project from the rear edge of the support surface **130**.

FIG. **13** shows a top view and FIG. **14** shows a bottom view of another embodiment of a sample tray **100'** with one compartment **120'** and one magnetically closing drawer **104'**. The

sample tray **100'** uses two magnets **150**, **152** to close and secure the drawer **104'** within the compartment **120'**. Instead of coupled for rotary motion, like the sample tray **100** of FIG. **3**, this sample tray **100'** can be fixed within the sample chamber.

While the invention has been shown and described with reference to specific preferred embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the following claims.

What is claimed is:

1. A sample tray for use in a sample manager of a liquid chromatography system, comprising:

a base having opposing spaced-apart side walls separated by a cross wall that divides the base into two compartments, with one compartment on each side of the cross wall, the side walls and cross wall bounding each of the two compartments on three sides, with a fourth side of each compartment being open, each compartment being sized to closely receive a sample-vial carrier, each compartment having a surface with a magnet affixed to an underside of the surface at an edge of the open fourth side of that compartment; and

a pair of drawers slidably coupled to the base, each drawer sliding into the open fourth side of one of the two compartments over the surface of that compartment, each drawer having a support surface for supporting a sample-vial carrier, the support surface having a top side and a bottom side, the support surface of each drawer having a magnet affixed on the bottom side, the magnet on the bottom side of the support surface of each drawer being in alignment with the magnet affixed to the underside of the surface of the compartment into which that drawer slides, the magnet of each drawer and the magnet of the compartment into which that drawer slides biasing that drawer into its compartment when the magnets are brought into proximity of each other.

2. The sample tray of claim **1**, wherein one of the two side walls in each compartment has one or more leaf springs extending laterally thereof towards an interior region of the compartment in order to bias a sample-vial carrier disposed within the drawer, when closed, towards the other side wall.

3. The sample tray of claim **1**, wherein the cross wall has a vertical hole for receiving a fastener by which to couple the sample tray to a drive mechanism underneath the sample tray, the vertical hole being located at a central point of the sample tray about which the sample tray turns when coupled to and rotated by the drive mechanism.

4. The sample tray of claim **1**, wherein only one of the two compartments has a hole extending through for use in calibrating a position of the sample tray.

5. The sample tray of claim **1**, wherein each compartment is approximately 5 inches in width and approximately 3.5 inches in depth.

6. The sample tray of claim **1**, wherein each drawer has opposing side edges, and each side edge of the drawer has a tongue extending laterally from that side edge, and wherein each compartment has opposing side platforms, each platform having a side groove for slidably receiving the tongue at one of the side edges of the drawer.

7. The sample tray of claim **1**, wherein each drawer has arching posts at a rear end of the drawer, for guiding a sample-vial carrier into position within the drawer.

8. A sample manager of a liquid chromatography system, comprising:

a thermal chamber;

a sample tray mounted within the thermal chamber, the sample tray comprising:

a base having opposing spaced-apart side walls separated by a cross wall that divides the base into two compartments, with one compartment on each side of the cross wall, the side walls and cross wall bounding each of the two compartments on three sides, with a fourth side of each compartment being open, each compartment being sized to closely receive a sample-vial carrier, each compartment having a top surface and a bottom surface with a magnet affixed to the bottom surface at an edge of the open fourth side of that compartment; and

a pair of drawers slidably coupled to the base, each drawer sliding into the open fourth side of one of the two compartments, each drawer having a support surface for supporting a sample-vial carrier, the support surface having a top side and a bottom side, the support surface of each drawer having a magnet affixed at an edge of the bottom side, the magnet at the edge of the bottom side of the support surface of each drawer being in alignment with the magnet affixed to the bottom surface of the compartment into which that drawer slides, the magnet of each drawer and the magnet of the compartment into which that drawer slides biasing that drawer into its compartment when the magnets are brought into proximity of each other.

9. The sample manager of claim **8**, further comprising:

a rotating drive mechanism disposed below the sample tray; and wherein the cross wall has a vertical hole for receiving a fastener by which to couple the sample tray to the rotating drive mechanism, the vertical hole being located at a central point of the sample tray about which the sample tray turns when rotated by the rotating drive mechanism.

10. The sample manager of claim **8**, wherein the sample tray has one or more leaf springs extending laterally from one of the two side walls in each compartment towards an interior region of that compartment in order to bias a sample-vial carrier disposed within that drawer, when closed, towards the other side wall of that compartment.

11. A liquid chromatography system, comprising:

a sample manager having a thermal chamber with a sample tray mounted therein, the sample tray comprising:

a base having opposing spaced-apart side walls separated by a cross wall that divides the base into two compartments, with one compartment on each side of the cross wall, the side walls and cross wall bounding each of the two compartments on three sides, with a fourth side of each compartment being open, each compartment being sized to closely receive a sample-vial carrier, each compartment having a top surface and a bottom surface with a magnet affixed to the bottom surface at an edge of the open fourth side of that compartment; and

a pair of drawers slidably coupled to the base, each drawer sliding into the open fourth side of one of the two compartments, each drawer having a support surface for supporting a sample-vial carrier, the support surface having a top side and a bottom side, the support surface of each drawer having a magnet affixed at an edge of the bottom side, the magnet at the edge of the bottom side of the support surface of each drawer being in alignment with the magnet affixed to the

bottom surface of the compartment into which that drawer slides, the magnet of each drawer and the magnet of the compartment into which that drawer slides biasing that drawer into its compartment when the magnets are brought into proximity of each other.

12. The liquid chromatography system of claim **10**, further comprising a rotating drive mechanism disposed below the sample tray; and wherein the cross wall has a vertical hole for receiving a fastener by which to couple the sample tray to the rotating drive mechanism, the vertical hole being located at a central point of the sample tray about which the sample tray turns when rotated by the rotating drive mechanism.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,194,847 B2
APPLICATION NO. : 13/519785
DATED : November 24, 2015
INVENTOR(S) : Joshua A. Burnett et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Column 9, Claim 12:
• In Line 6, replace "claim 10" with "claim 11".

Signed and Sealed this
Third Day of January, 2017

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office